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PHILOSOPHICAL TRANSACTIONS.

I. *An Account of the Diſcovery of the Manner of making Iſinglaſs in* Ruſſia; *with a particular Deſcription of its Manufacture in* England, *from the Produce of* Britiſh *Fiſheries. In a Letter from* Humphrey Jackſon, *Eſq*; *F. R. S. to* William Watſon, *M. D. F. R. S.*

SIR,

Read Nov. 19, 1772. YOUR diſtinguiſhed zeal to promote ſcience in general, and particularly ſuch arts as tend to improve the commerce

of your country, incites me to addreſs to you the following account of the genuine manufacture of foreign iſinglaſs, with the method of making it in England from Britiſh materials. If you ſhould judge the ſubject deſerving attention, you will do me great honour in preſenting this paper to the Royal Society: but this I beg leave to ſubmit to your judgement and candour, and to ſubſcribe myſelf,

With great eſteem,

SIR,

Your moſt obliged,

and moſt obedient

humble ſervant,

Great Tower-Hill,
June 15, 1772.

Humphrey Jackſon.

ALL

ALL authors, who have hitherto delivered proceſſes for making ichthyocolla, fiſh-glue or iſinglaſs, have greatly miſtaken both its conſtituent matter and preparation.

To prove this aſſertion, it may not be improper to recite what Pomet ſays upon the ſubject, as he appears to be the principal author whom the reſt have copied *. After deſcribing the fiſh, and referring to a cut engraved from an original in his cuſtody, he ſays: 'As to the manner of making the 'iſinglaſs, the ſinewy parts of the fiſh are boiled 'in water, till all of them be diſſolved that will diſ-'ſolve; then the gluey liquor is ſtrained, and ſet to 'cool. Being cold, the fat is carefully taken off, 'and the liquor itſelf boiled to a juſt conſiſtency, 'then cut to pieces, and made into a twiſt, bent in 'form of a creſcent, as commonly ſold, then hung 'upon a ſtring, and carefully dried.'

From this account, it might be rationally concluded that every ſpecies of fiſh which contained gelatinous principles would yield iſinglaſs: and this parity of reaſoning ſeems to have given riſe to the haſty concluſions of thoſe, who ſtrenuouſly vouch for the extraction of iſinglaſs from ſturgeon; but as that fiſh is eaſily procureable, the negligence of aſcertaining the fact by experiment ſeems inexcuſeable.

Every traveller, as well as author, who mentions iſinglaſs, obſerves that it is made from certain fiſh

* See Pomet's Hiſtory of Drugs, and Caſpar Neuman's Chemiſtry, Engliſh tranſlations. Hiſt. Materiæ Medicæ, Vogel. Lewis's Materia Medica. Doſſie's Inſtitutes of Chemiſtry.

found in the Danube and rivers of Muſcovy. Willughby and others inform us, that it is made of the ſound of the * Beluga; Caſpar Newman that it is made of the Huſo Germanorum and other fiſh, which he has ſeen frequently ſold in the public markets of Vienna. Theſe circumſtances make it appear the more extraordinary, that a perfect account of the manufacture of ſuch an eſſential article of commerce ſhould remain ſo long unrevealed.

In my firſt attempts to diſcover the conſtituent parts and manufacture of iſinglaſs, relying too much upon the authority of ſome chemical authors, whoſe veracity I had experienced in many other inſtances, I found myſelf conſtantly diſappointed. Glue, not iſinglaſs, was the reſult of every proceſs; and although, in the ſame view, a journey to Ruſſia proved fruitleſs, yet a ſteady perſeverance in the reſearch proved not only ſucceſsful as to this object, but, in the purſuit to diſcover a reſinous matter plentifully procureable in the † Britiſh fiſheries, which has been found, by ample experience, to anſwer ſimilar purpoſes. It is now no longer a ſecret that our ‡ lakes and rivers in North America are ſtocked

* Vide Specimen Hiſtor. Nat. Volg. Auctore J. R. Forſter, Philoſ. Tranſ. 1767.

† Upwards of forty tons of Britiſh iſinglaſs have been manufactured and conſumed ſince this diſcovery was firſt made.

‡ As the lakes of North America lie nearly in the ſame latitude with the Caſpian Sea, particularly Lake Superior, which is ſaid to be of greater extent, it was conjectured they might abound with the ſame ſorts of fiſh, and, in conſequence of public advertiſements diſtributed in various parts of North America, offering premiums for the ſounds of ſturgeon, and other fiſh, for the purpoſe of making iſinglaſs, ſeveral ſpecimens of fine

with

with immenſe quantities of fiſh, ſaid to be the ſame ſpecies with thoſe in Muſcovy, and yielding the fineſt iſinglaſs, the fiſheries whereof, under due encouragement, would doubtleſs ſupply all Europe with this valuable article.

But to return, no artificial heat is neceſſary to the production of iſinglaſs, neither is the matter diſſolved for this purpoſe; for, as the continuity of its fibres would be deſtroyed by ſolution, the maſs would become brittle in drying, and ſnap ſhort aſunder, which is always the caſe with glue, but never with iſinglaſs. The latter, indeed, may be reſolved into glue with boiling water, but its fibrous recompoſition would be found impracticable afterwards, and a fibrous texture is one of the moſt diſtinguiſhing characteriſtics of genuine iſinglaſs. The reproduction of leather might, with equal reaſon, be attempted from the former.

A due conſideration that an imperfect ſolution of iſinglaſs, called fining by the brewers, poſſeſſed a peculiar property of clarifying malt liquors, induced me to attempt its analyſis in cold ſubacid menſtruums. One ounce and a half of good iſinglaſs, ſteeped a few days in one gallon of ſtale beer, was converted into good fining, of a remarkable thick conſiſtence: the ſame quantity of glue, under ſimilar treatment, yielded only a mucilaginous liquor, reſembling diluted gum-water, which, inſtead of clarifying beer, increaſed both its tenacity and turbidneſs, and communicated other properties in no

iſinglaſs, the produce of fiſh taken in theſe parts, have been lately ſent to England, with proper atteſtations as to the unlimited quantity which may be procured.

reſpect

reſpect correſponding with thoſe of genuine fining. On commixing three ſpoonfuls with a gallon of malt liquor, in a tall cylindrical glaſs, a vaſt number of curdly maſſes became preſently formed, by the reciprocal attraction of the particles of iſinglaſs and the feculencies of the beer, which, increaſing in magnitude and ſpecific gravity, arranged themſelves accordingly, and fell in a combined ſtate to the bottom, through the well-known laws of gravitation; for, in this caſe, there is no elective attraction, as ſome have imagined, which bears the leaſt affinity with what frequently occurs in chemical decompoſitions.

Theſe phænomena are adduced here as correlative proofs of the impracticability of making iſinglaſs by the previous reduction of the ſinewy parts of fiſh into jelly; and it ſeems evident, that the clarifying action of iſinglaſs depends principally upon a crude minute diviſion, not ſolution of its parts, which is ſtill farther confirmed, by diluting a few drops of fining with fair water in a glaſs; for thus the ſlender filaments become conſpicuous to the eye, eſpecially when aſſiſted with a double convex lens, but theſe immediately diſappear on an addition of hot water.

As the general proceſſes for making iſinglaſs appear from hence illuſive and erroneous, the long concealed principles of its manufacture into the various common forms and ſhapes become more obvious and comprehenſive. If what is commercially termed long or ſhort ſtapled iſinglaſs be ſteeped a few hours in fair cold water, the entwiſted membranes will expand, and reaſſume their original beau-

ful * hue, and, by a dextrous addreſs, may be perfectly unfolded. By this ſimple operation, we find that iſinglaſs is actually nothing more than certain membranous parts of fiſhes, diveſted of their native mucoſity, rolled and twiſted into the forms above-mentioned, and dried in the open air.

The ſounds, or air-bladders of freſh-water fiſh, in general, are preferred for this purpoſe, as being the moſt tranſparent, flexible, delicate ſubſtances. Theſe conſtitute the fineſt ſorts of iſinglaſs; thoſe called book and ordinary ſtaple, are made of the inteſtines, and probably the peritonæum, of the fiſh. The Beluga yields the greateſt quantity, as being the largeſt and moſt plentiful fiſh in the Muſcovy rivers; but the ſounds of all freſh-water fiſh yield, more or leſs, fine iſinglaſs, particularly the ſmaller ſorts, found in prodigious quantities in the Caſpian ſea, and ſeveral hundred miles beyond Aſtracan, in the Wolga, Yaik, Don, and even as far as Siberia, where it is called *kle* or *kla* by the natives, which implies a glutinous matter; it is the baſis of the Ruſſian glue, which is preferred to all other kinds for its ſtrength.

The anatomy and † uſes of the ſound in fiſh ſeems not yet adjuſted by ichthyologiſts. I have not met with a genuine deſcription of its ſituation and

* If the fine tranſparent iſinglaſs be held in certain poſitions to the light, it frequently exhibits beautiful priſmatic colours.

† Fiſhermen have a dextrous art in perforating the ſound of freſh-taken cod fiſh with a needle, in order to diſengage the incloſed air. Without this operation, the fiſh could not be kept under water in the well-boat, conſequently could not live; but if by accident the operator wounds an artery, the fiſh preſently dies, through the diſcharge of bood, to the loſs of the proprietor, who thus can ſeldom bring it ſweet to market.

figure

figure in any author. A modern writer * will have it to be the meſentery of the fiſh; but the celebrated Gouan, the lateſt, and perhaps the moſt accurate author on icthyology, gives a more ſatisfactory and comprehenſive account of it, under the title of † *La Veſicule Aërienne.* Yet, if the identity of the air-bladder, and what, in Engliſh, is called ſound, be admitted, which ſeems particularly aſcertained in a certain genus, viz. the Aſellus of Willughby, or Gadus of Artedi, his deſcription is a little erroneous with reſpect to its termination near the *Veſica urinaria*; for in cod and ling, the continuation of the ſound, or air-bladder, may be eaſily traced from thence to the laſt *vertebra* adjoining the tail.

The ſounds, which yield the finer iſinglaſs, conſiſt of parallel fibres, and are eaſily rent longitudinally; but the ordinary ſorts are found compoſod of double membranes, whoſe fibres croſs each other obliquely, reſembling the coats of a bladder; hence the former are more readily pervaded and divided with ſubacid

* Doſſie, in Memoirs of Agriculture.

† La Véſicule aërienne eſt un ſac membraneux compoſé de deux ou trois envelopes, qui ſe ſeparent facilement, & rempli d'air, à la faveur duquel les poiſſons ſe ſoutiennent dans l'eau. Il eſt pour l'ordinaire ſitué en long, enfermé dans le peritoine, placé entre les vertebres & l'eſtomac. Sa longueur dépend de la capacité du bas ventre, & de la grandeur du poiſſon: il eſt tantôt cylindrique, elliptique, ové ou renverſé, tantôt à deux lobes & à deux loges, tantôt à trois lobes & à trois loges, &c. dans les males il deſcend preſque juſqu' à la region de la veſſie urinaire.

Cette Veſicule eſt attachée avec l'eſtomac, avec l'eſophage, ſans le diaphragme, tantôt par le côté tantôt par la pointe & ſ'y abbouche par un conduit pneumatique. Goüan, Hiſtoire des Poiſſons.

liquors;

liquors; but the latter, through a peculiar kind of interwoven texture, are with great difficulty torn aſunder, and long reſiſt the power of the ſame menſtruum; yet, when duly reſolved, are found to act with equal energy in clarifying liquors.

Iſinglaſs receives its different ſhapes in the following manner.

The parts, of which it is compoſed, particularly the ſounds, are taken from the fiſh while ſweet and freſh, ſlit open, waſhed from their ſlimy *ſordes*, diveſted of every thin membrane which invelopes the ſound, and then expoſed to ſtiffen a little in the air. In this ſtate, they are formed into rolls about the thickneſs of a finger, and in length according to the intended ſize of the ſtaple: a thin membrane is generally ſelected for the center of the roll, round which the reſt are folded alternately, and about half an inch of each extremity of the roll is turned inwards. The due dimenſions being thus obtained, the two ends of what is called ſhort ſtaple are pinned together with a ſmall wooden * peg; the middle of the roll is then preſſed a little downwards, which gives it the reſemblance of a heart ſhape, and thus it is laid on boards, or hung up in the air to dry. The ſounds, which compoſe the long ſtaple, are larger than the former; but the operator lengthens this ſort at pleaſure, by interfolding the ends of one or more pieces of the ſound with each other. The extremities are faſtened with a peg, like the former; but the middle part of the roll is bent more conſiderably down-

* See the annexed Drawings [TAB. I. Fig. 1.]

wards; and, in order to preſerve the * ſhape of the three obtuſe angles thus formed, a piece of round ſtick, about a quarter of an inch diameter, is faſtened in each angle with ſmall wooden pegs, in the ſame manner as the ends. In this ſtate, it is permitted to dry long enough to retain its form, when the pegs and ſticks are taken out, and the drying completed; laſtly, the pieces of iſinglaſs are colligated in rows, by running packthread through the peg-holes, for convenience of package and exportation.

The membranes of the † book ſort, being thick and refractory, will not admit a ſimilar formation with the preceding: the pieces therefore, after their ſides are folded inwardly, are bent in the center, in ſuch manner that the oppoſite ſides reſemble the cover of a book, from whence its name; a peg being run acroſs the middle, faſtens the ſides together, and thus it is dried like the former. This ſort is interleaved, and the pegs run acroſs the ends, the better to prevent its unfolding.

That called cake iſinglaſs is formed of the bits and fragments of the ſtaple ſorts, put into a flat metalline pan, with a very little water, and heated juſt enough to make the parts cohere like a pancake, when it is dried; but frequently it is overheated, and ſuch pieces, as before obſerved, are uſeleſs in the buſineſs of fining. Experience has taught the conſumers to reject them.

Iſinglaſs is beſt made in the ſummer, as froſt gives it a diſagreeable colour, deprives it of weight, and

* See Fig. 3.
† Fig. 4.

impairs

impairs its gelatinous principles; its faſhionable forms are unneceſſary, and frequently injurious to its native qualities. It is common to find oily putrid matter and *exuviæ* of inſects between the implicated membranes, which, through the inattention of the cellarman, often contaminate wines and malt liquors in the act of clarification. Theſe peculiar ſhapes might, probably, be introduced originally with a view to conceal and diſguiſe the real ſubſtance of iſinglaſs, and preſerve the monopoly; but, as the maſk is now taken off, it cannot be doubted to anſwer every purpoſe more effectually in its * native ſtate, without any ſubſequent manufacture whatever, eſpecially to the principal conſumers, who hence will be enabled to procure ſufficient ſupply from the Britiſh colonies. Until this laudable end can be fully accompliſhed, and as a ſpecies of iſinglaſs, more eaſily producible from the marine fiſheries, may probably be more immediately encouraged, it may be manufactured as follows.

The ſounds of cod and ling bear great analogy with thoſe of the *accipenſer genus* of Linnæus and Artedi, and are in general ſo well known, as to require no particular deſcription. The Newfoundland and Iceland fiſhermen ſplit open the fiſh, as ſoon as taken, and throw the back-bones, with the ſounds annexed, in a heap; but, previous to incipient putrefaction, the ſounds are cut out, waſhed from their ſlimes, and ſalted for uſe. In cutting out the ſounds, the intercoſtal parts are left behind, which are much the beſt; the Iceland fiſhermen are ſo ſenſible of

* See Fig. 5.

this, that they beat the bone upon a block with a thick ſtick, till the pockets, as they term them, come out eaſily, and thus preſerve the ſound entire. If the ſounds have been cured with ſalt, that muſt be diſſolved by ſteeping them in water, before they are prepared for iſinglaſs; the freſh ſound muſt then be laid upon a block of wood, whoſe ſurface is a little elliptical, to the end of which a ſmall hair bruſh is nailed, and with a * ſaw-knife, the membranes on each ſide of the ſound muſt be ſcraped off. The knife is rubbed upon the bruſh occaſionally, to clear its teeth; the pockets are cut open with ſciſſars, and perfectly cleanſed of the mucous matter with a coarſe cloth: the ſounds are afterwards waſhed a few minutes in lime-water, in order to abſorb their oily principle, and laſtly in clear water. They are then laid upon nets, to dry in the air; but, if intended to reſemble foreign iſinglaſs, the ſounds of cod will only admit of that called book, but thoſe of ling both ſhapes. The thicker the ſounds are, the better the iſinglaſs, colour excepted; but that is immaterial to the brewer, who is its chief conſumer.

This iſinglaſs reſolves into fining, like the other ſorts, in ſubacid liquors, as ſtale beer, cyder, old hock, &c. and in equal quantities produces ſimilar effects upon turbid liquors, except that it falls ſpeedier and cloſer to the bottom of the veſſel, as may be demonſtrated in tall cylindrical glaſſes; but foreign iſinglaſs retains the conſiſtency of fining preferably in warm weather, owing to the greater tenacity of its native mucilage.

* See Fig. 2.

Vegetable

Vegetable acids are, in every reſpect, beſt adapted to fining: the mineral acids are too corroſive, and even inſalubrious in common beverage

It is remarkable that, during the converſion of iſinglaſs into fining, the acidity of the menſtruum ſeems greatly diminiſhed, at leaſt to taſte, not on account of any alkaline property in the iſinglaſs, probably, but by its inveloping the acid particles. It is likewiſe reducible into jelly with alkaline liquors, which indeed are ſolvents of all animal matters; even cold lime-water diſſolves it into a pulpous *magma*. Notwithſtanding this is inadmiſſible as fining, on account of the menſtruum, it produces an admirable effect in other reſpects: for, on commixture with compoſitions of plaſter, lime, &c. for ornamenting walls expoſed to viciſſitudes of weather, it adds firmneſs and permanency to the cement; and if common brick-mortar be worked up with this jelly, it ſoon becomes almoſt as hard as the brick itſelf: but, for this purpoſe, it is more commodiouſly prepared, by diſſolving it in cold water, acidulated with vitriolic acid; in which caſe, the acid quits the jelly, and forms with the lime a *ſelenitic* maſs, while, at the ſame time, the jelly being deprived, in ſome meaſure, of its moiſture, through the formation of an indiſſoluble concrete amongſt its parts, ſoon dries, and hardens into a firm body; whence its ſuperior ſtrength and durability are eaſily comprehended.

It has long been a prevalent opinion, that ſturgeon, on account of its cartilaginous nature, would yield great quantities of iſinglaſs; but, on examination, no part of this fiſh, except the inner coat of the ſound, promiſed the leaſt ſucceſs. This being full

of

of *rugæ*, adheres ſo firmly to the external membrane, which is uſeleſs, that the labour of ſeparating them ſuperſedes the advantage. The inteſtines, however, which in the larger fiſh extend ſeveral yards in length, being cleanſed from their mucus, and dried, were found ſurprizingly ſtrong and elaſtic, reſembling cords made with the inteſtines of other animals, commonly called cat-gut, and, from ſome trials, promiſed ſuperior advantages, when applied to mechanic operations.

Having now ſufficiently revealed the principal *arcana* in the manufacture of iſinglaſs, and explained ſome of its leaſt known phænomena and properties, the farther proſecution thereof, as a commercial buſineſs, is left to others, whoſe future inquiries into the ſubject, it is hoped, will, in ſome reſpect, be anticipated through this narrative; but whatever ſucceſs may attend the attempt, I flatter myſelf to ſtand acquitted, in having contributed every thing in my power to its advancement and perfection.

Fig. 1

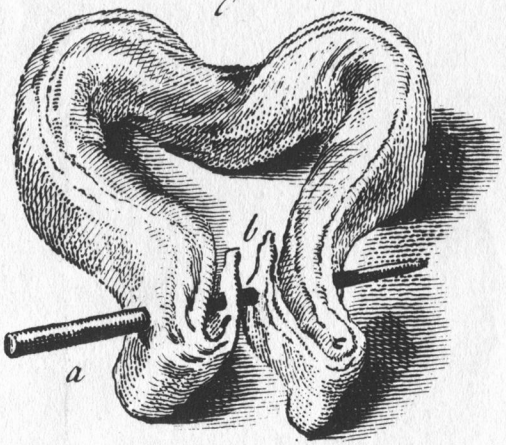




Fig. 2.

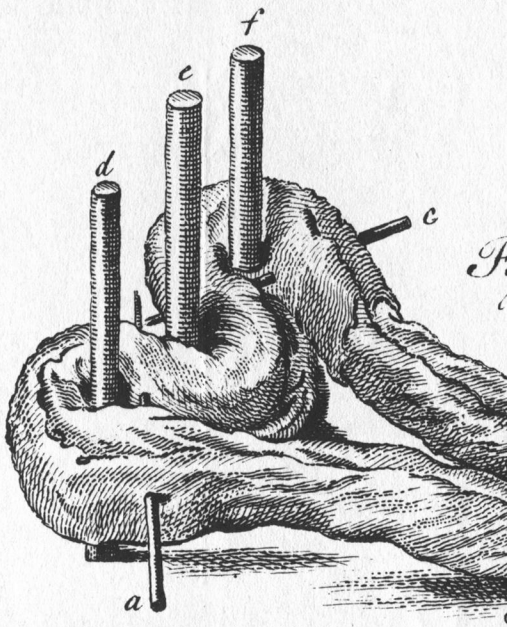


Fig. 5.

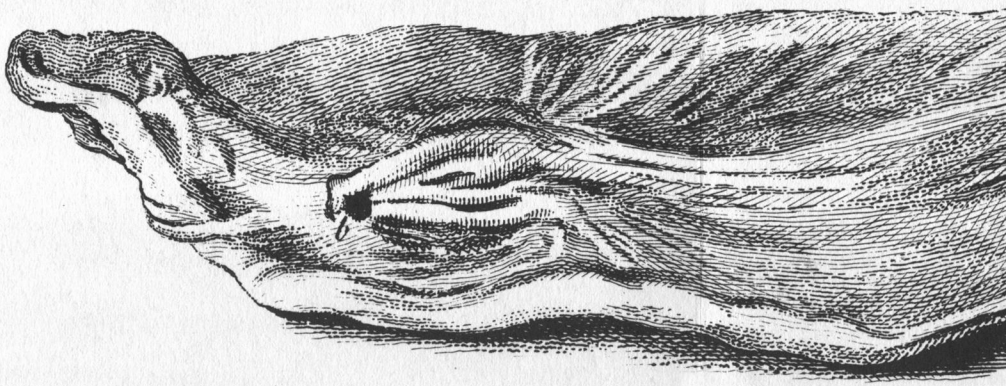


Fig. 3.

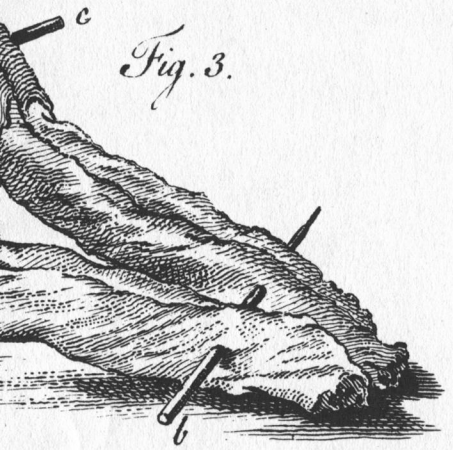


Fig. 4.

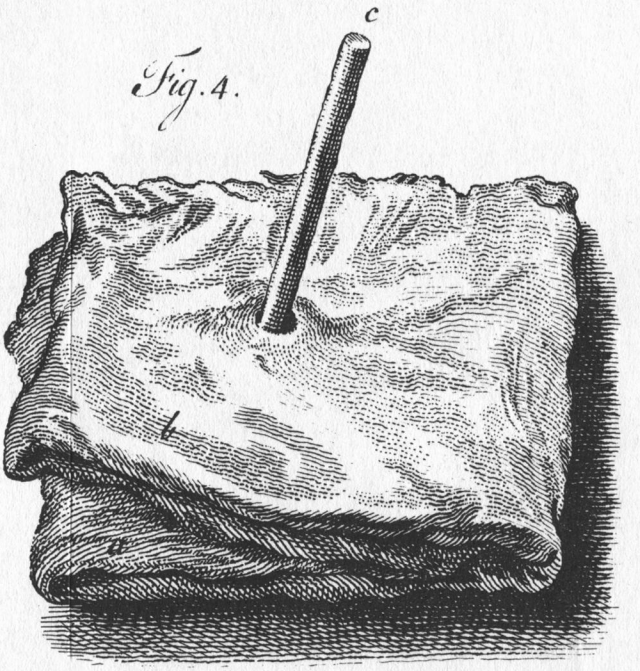
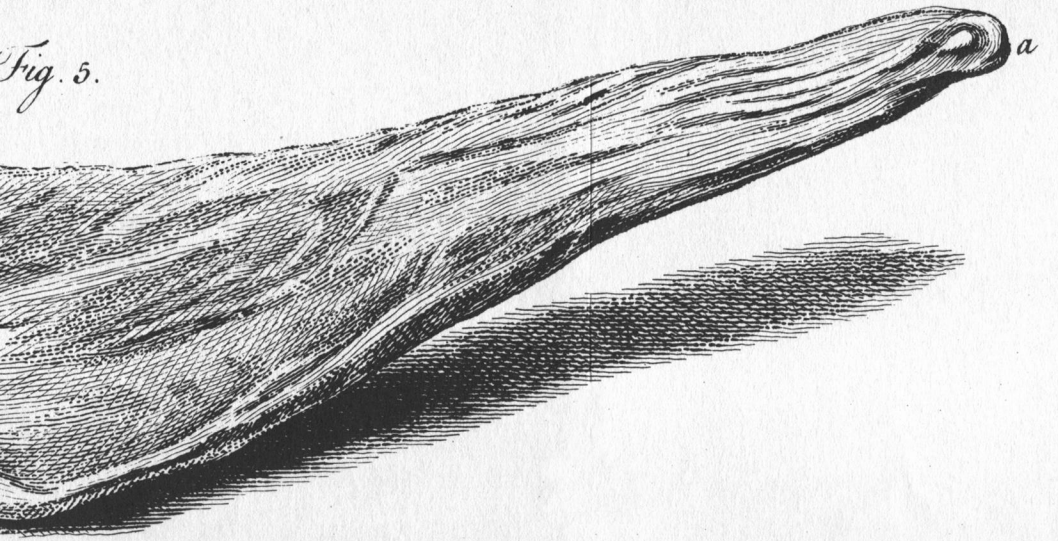


Fig. 5.



EXPLANATION of the Figures; TAB. I.

Fig. 1. Short ſtaple iſinglaſs.
a The wooden peg, which faſtens the two ends of the iſinglaſs.
b The extremities folded inwards.

Fig. 2. The ſaw-knife.

Fig. 3. Long ſtaple iſinglaſs.
a b c Wooden pegs or pins.
d e f Three round ſticks, or pieces of wood, faſtened in the angles of the iſinglaſs by the pins *a* and *c*.

Fig. 4. Book iſinglaſs.
a b The two ſides, which reſemble the cover of a book.
c The wooden pin run through the ſides, to faſten them together.

Fig. 5. The entire ſound, or *veſica aeria*, of the iſinglaſs fiſh dried in its natural ſtate.
a The hole made for the packthread, wherewith it is hung up to dry.
b The orifice of part of the pneumatic veſſels left with the ſound.